

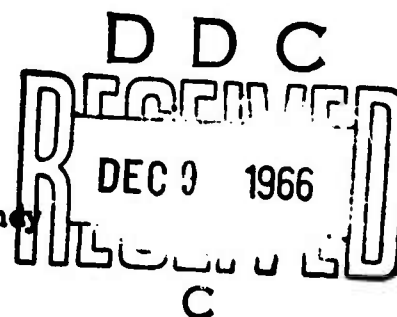


AD

Report No. SA-TR20-2818

**FORTTRAN PROGRAM FOR CALCULATING PROBABILITY OF
A HIT ON A SQUARE TARGET**

Technical Report



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Hasel B. Lundy

Date 15 September 1966

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REPORT: SA-TR20-2818

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**FORTTRAN PROGRAM
FOR CALCULATING PROBABILITY OF A HIT ON A SQUARE TARGET**

Technical Report

Hazel E. Lundy

DA PROJECT TITLE: Investigation of Gun Type Aerial Weapons

DA PROJECT: 1X120301D02503

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ABSTRACT

Probability of a hit by a single shot or by a ten-shot burst at direct or angular approach to a square target is calculated. Parameters include dispersion in mils, distance from the target in meters, and size of the target in feet. A normal distribution is assumed. Solution by linear interpolation of normal curve areas from standard tables was accurate to 0.0002 when contrasted with integration of the normal curve by Simpson's 1/3 Rule in sample problems.

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FORTTRAN PROGRAM
FOR CALCULATING PROBABILITY OF A HIT ON A SQUARE TARGET

1. PURPOSE

To record three variations of a computer program in FORTRAN which have been used for calculating the probability of a hit on a square upright target based on assumption of a normal distribution in both the horizontal and vertical directions.

2. DISCUSSION

a. Calculations described below may be performed by use of these FORTRAN programs:

- (1) P_{HIT} on a square target - detailed calculations for single-shot hit probability based on normal curve areas (Program R453R).
- (2) P_{HIT} on a square target - single shot and ten-shot bursts at direct approach and at any two angular approaches with provision for regular incrementation of radial standard deviation in mils, distance from the target in meters, and size of the target in feet.
 - (a) Calculated by linear interpolation of normal curve areas from standard tables (Program R454R).
 - (b) Calculated by integration of the normal curve by Simpson's 1/3 Rule (Program R455R).

b. Sample calculations in this report show the same problem solved in the following ways:

- (1) By use of Program R455R with 101 incremental areas,
- (2) By use of Program R455R with 11 incremental areas,
- (3) By use of Program R454R.

c. Values of P_{HIT} for the sample problem, rounded to four decimal places, varied at most by .0002 whether calculated by Program R455R with 101 or with 11 incremental areas of integration or by the linear interpolation method of Program R454R. However, calculation by (1) involving the 101 incremental areas required approximately 3-1/2 times longer than calculations by (2) and (3). This calculation required 7 minutes on the Springfield Armory 8K computer as compared with 2 minutes each for (2) and (3).

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3. PROGRAM R453R

a. DESCRIPTION

This program gives detailed calculations for probability of a hit by a single shot based on conversion of a projected radial standard deviation in miles to linear standard deviation in feet and linear interpolation of 400 stored values of area of the normal curve. Range (distance from the target) is given in meters. Load limits equal 2074(DECIMAL) words.

b. OUTPUT AND SAMPLE CALCULATIONS

- (1) Values of the normal curve as read in from cards are printed as the first page of output.
- (2) Second and subsequent pages include columns described below. The sample calculations for one line of output are based on a 6.5-mil radial standard deviation delivered at 1500 meters to a 50-foot square target.

Column 1. Radial Standard Deviation

$$RSD = \sqrt{\sigma_x^2 + \sigma_y^2} = 6.5, \text{ where } \sigma_x = \sigma_y$$

Column 2. Linear Standard Deviation

Conversion Factor for RSD in miles to LSD in feet

$$\frac{1.5 \times 3.280833}{1.414214} = 3.47984$$

$$LSD = 6.5 \times 3.47984 = 22.6190 \text{ feet}$$

Column 3. Z

$$Z = \frac{X}{\sigma} = \frac{25}{22.61896} = 1.1053$$

3. PROGRAM R453R - Continued

b. OUTPUT AND SAMPLE CALCULATIONS

Column 4. Difference

Difference between values of normal curve area
adjacent to 1.1053

<u>Z</u>	<u>Normal Curve Area</u>
1.11	.3665
1.10	<u>.3643</u>
Difference	.0022

Column 5. Interpolation

$$.0022 \times (1.1053 - 1.10) \times 100 = .0012$$

Column 6. Area of Normal Curve

The low adjacent value of Z = .3643

Column 7. PHX on Half of Target

Probability of a hit on half of the target in the
X direction equals .3643 plus .0012 = .3655

Column 8. PHX on Full Target

$$2 \times .3655 = .7310$$

Column 9. P_{HIT} on Full Target, X and Y Directions

$$.7310 \times .7310 = .5342$$

Column 10. Percentage

$$100 \times .5342 = 53.42 \text{ Per Cent}$$

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3. PROGRAM R453R - Continued

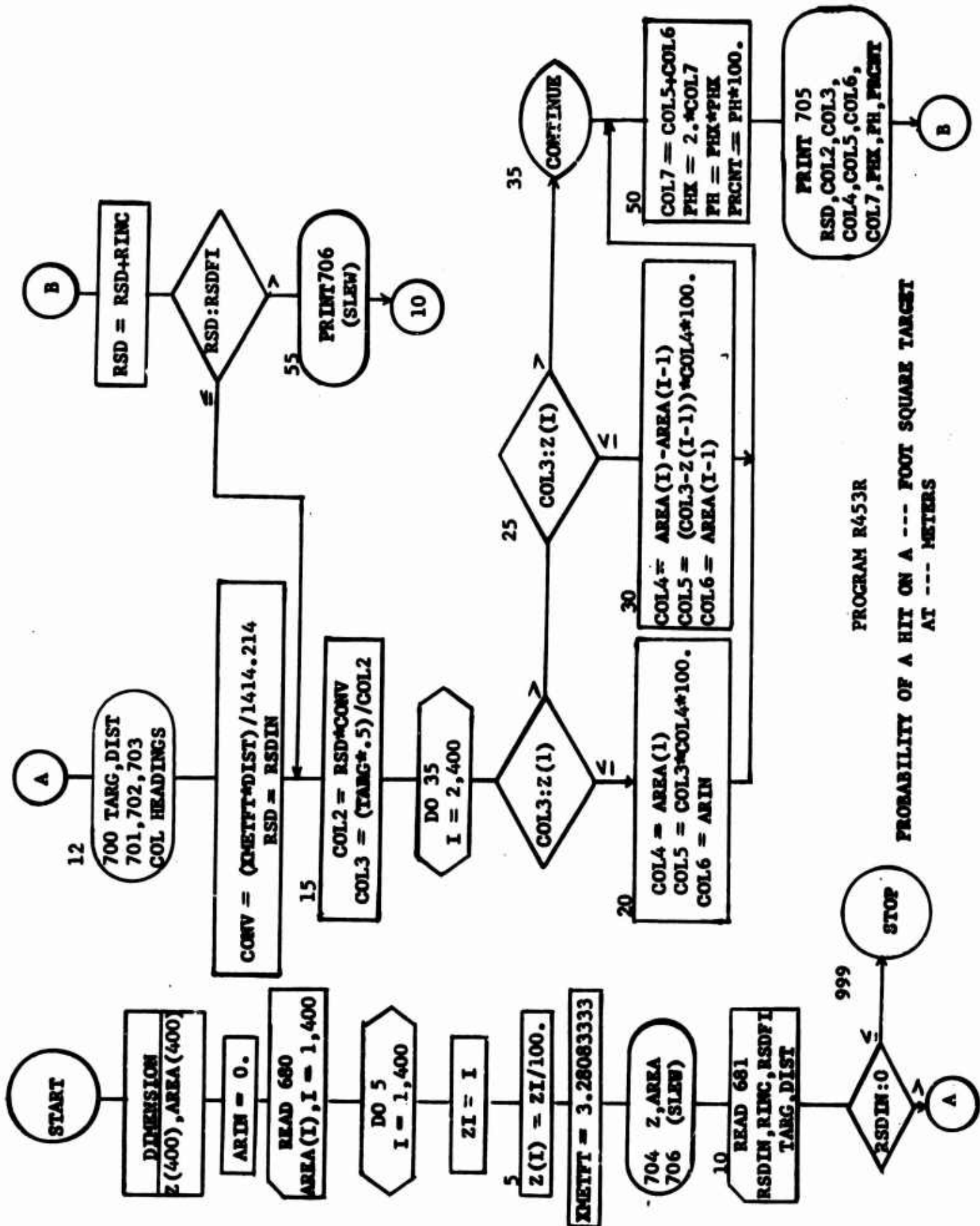
c. INPUT

- (1) Set of 50 cards with values of the normal curve area from standard tables, 8 values per card, total of 400 values.

	<u>Column</u>		<u>Column</u>	
First Card.	1-4	0040	41-44	0199
	11-14	0080	51-54	0239
	21-24	0120	61-64	0279
	31-34	0160	71-74	0319
Fiftieth Card.	1-4	5000	41-44	5000
	11-14	5000	51-54	5000
	21-24	5000	61-64	5000
	31-34	5000	71-74	5000

- (2) Followed by Data Cards

<u>Column</u>	<u>Variable Name</u>	<u>Description</u>
1-10	RSDIN	Initial radial std. dev. - miles
11-20	RINC	Increments of RSD
21-30	RSDFI	Final RSD - miles
31-40	TARC	Length and width of target - feet
41-50	DIST	Range - meters



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```

C
C
C  PROBABILITY OF A HIT ON A --- FOOT SQUARE TARGET AT ---- METERS
C  PROGRAM NO. R453R  CHARGE TO R701R  BY H. LUNDY
C  DIMENSION Z(400), AREA(400)
C  ARIN = 0.
C  READ 680,(AREA(I),I = 1,400)
C  DO 5 I = 1,400
C  ZI = I
C      5 Z(I) = ZI/100.
C  XMETFT = 3.28083333
C  PRINT 704,(Z(I),AREA(I),I = 1,400)
C  PRINT 706
C  10 READ 681, RSDIN,RINC,RSDFI,TARG,DIST
C  IF(RSDIN) 999,999,12
C  12 PRINT 700,TARG,DIST
C  PRINT 701
C  PRINT 702
C  PRINT 703
C  CONV = (XMETFT * DIST) / 1414.214
C  RSD = RSDIN
C  15 COL2 = RSD * CONV
C  COL3 = (TARG * .5) / COL2
C  DO 35 I = 2,400
C  IF(COL3-Z(I)) 20,20,25
C  20 COL4 = AREA(I)
C  COL5 = COL3 * COL4 * 100.
C  COL6 = ARIN
C  GO TO 50
C  25 IF(COL3 - Z(I)) 30,30,35
C  30 COL4 = AREA(I) - AREA(I-1)
C  COL5 = (COL3 - Z(I-1)) * COL4 * 100.
C  COL6 = AREA(I-1)
C  GO TO 50
C  35 CONTINUE
C  50 COL7 = COL5 + COL6
C  PHX = 2.*COL7
C  PH = PHX * PHX
C  PRCNT = PH * 100.

```

```

PRINT 705, RSD,COL2,COL3,COL4,COL5,COL6,COL7,PHX,PH,PRCNT
RSD = RSD + RINC
IF(RSD - RSDFI) 15,15,55
55 PRINT 706
GO TO 10
999 STOP
680 FORMAT (8(F4.4,6X))
681 FORMAT (5F10.0)
700 FORMAT (8X,25HPRORABILITY OF A HIT ON A, F6.2,23H FOOT SQUARE TA
1RGET AT,F6.0,8H METERS//)
701 FORMAT (74H RADIAL LINEAR
1PHX PHX PH)
702 FORMAT (82H STD DEV STD DEV
1 HALF FULL FULL TGT PER)
703 FORMAT (83H -MILS -FEET
1 TGT TARGET X AND Y CENT//)
704 FORMAT(10(F5.2,F7.4))
705 FORMAT (F7.1,F12.4,7F8.4,F9.2)
706 FORMAT (1H1)
END

```

SECRET
24-1130-2818

0.01	0.0040	0.002	0.0080	0.003	0.0120	0.004	0.0160	0.005	0.0199	0.006	0.0239	0.007	0.0279	0.008	0.0319	0.009	0.0359	0.010	0.0390
0.11	0.0438	0.12	0.0478	0.13	0.0517	0.14	0.0557	0.15	0.0596	0.16	0.0636	0.17	0.0675	0.18	0.0714	0.19	0.0753	0.20	0.0793
0.21	0.0832	0.22	0.0871	0.23	0.0910	0.24	0.0948	0.25	0.0987	0.26	0.1026	0.27	0.1064	0.28	0.1103	0.29	0.1141	0.30	0.1179
0.31	0.1217	0.32	0.1255	0.33	0.1293	0.34	0.1331	0.35	0.1368	0.36	0.1406	0.37	0.1443	0.38	0.1480	0.39	0.1517	0.40	0.1554
0.41	0.1591	0.42	0.1628	0.43	0.1664	0.44	0.1700	0.45	0.1736	0.46	0.1772	0.47	0.1808	0.48	0.1844	0.49	0.1879	0.50	0.1915
0.51	0.1950	0.52	0.1985	0.53	0.2019	0.54	0.2054	0.55	0.2088	0.56	0.2123	0.57	0.2157	0.58	0.2190	0.59	0.2224	0.60	0.2257
0.61	0.2291	0.62	0.2324	0.63	0.2357	0.64	0.2389	0.65	0.2422	0.66	0.2454	0.67	0.2486	0.68	0.2517	0.69	0.2549	0.70	0.2580
0.71	0.2611	0.72	0.2642	0.73	0.2673	0.74	0.2704	0.75	0.2734	0.76	0.2764	0.77	0.2794	0.78	0.2823	0.79	0.2852	0.80	0.2881
0.81	0.2910	0.82	0.2939	0.83	0.2967	0.84	0.2995	0.85	0.3023	0.86	0.3051	0.87	0.3078	0.88	0.3106	0.89	0.3133	0.90	0.3159
0.91	0.3186	0.92	0.3212	0.93	0.3238	0.94	0.3264	0.95	0.3289	0.96	0.3315	0.97	0.3340	0.98	0.3365	0.99	0.3389	1.00	0.3413
1.01	0.3438	1.02	0.3461	1.03	0.3485	1.04	0.3508	1.05	0.3531	1.06	0.3554	1.07	0.3577	1.08	0.3599	1.09	0.3621	1.10	0.3643
1.11	0.3665	1.12	0.3686	1.13	0.3708	1.14	0.3729	1.15	0.3749	1.16	0.3770	1.17	0.3790	1.18	0.3818	1.19	0.3830	1.20	0.3849
1.21	0.3869	1.22	0.3888	1.23	0.3907	1.24	0.3925	1.25	0.3944	1.26	0.3962	1.27	0.3980	1.28	0.3997	1.29	0.4015	1.30	0.4032
1.31	0.4049	1.32	0.4066	1.33	0.4082	1.34	0.4099	1.35	0.4115	1.36	0.4131	1.37	0.4147	1.38	0.4162	1.39	0.4177	1.40	0.4192
1.41	0.4207	1.42	0.4222	1.43	0.4236	1.44	0.4251	1.45	0.4265	1.46	0.4279	1.47	0.4292	1.48	0.4306	1.49	0.4319	1.50	0.4332
1.51	0.4345	1.52	0.4357	1.53	0.4370	1.54	0.4382	1.55	0.4394	1.56	0.4406	1.57	0.4418	1.58	0.4429	1.59	0.4441	1.60	0.4452
1.61	0.4463	1.62	0.4474	1.63	0.4484	1.64	0.4495	1.65	0.4505	1.66	0.4515	1.67	0.4525	1.68	0.4535	1.69	0.4545	1.70	0.4554
1.71	0.4564	1.72	0.4573	1.73	0.4582	1.74	0.4591	1.75	0.4599	1.76	0.4608	1.77	0.4616	1.78	0.4625	1.79	0.4633	1.80	0.4641
1.81	0.4649	1.82	0.4656	1.83	0.4664	1.84	0.4671	1.85	0.4678	1.86	0.4686	1.87	0.4693	1.88	0.4699	1.89	0.4706	1.90	0.4713
1.91	0.4719	1.92	0.4726	1.93	0.4732	1.94	0.4738	1.95	0.4744	1.96	0.4750	1.97	0.4756	1.98	0.4761	1.99	0.4767	2.00	0.4772
2.01	0.4778	2.02	0.4783	2.03	0.4788	2.04	0.4793	2.05	0.4798	2.06	0.4803	2.07	0.4808	2.08	0.4812	2.09	0.4817	2.10	0.4821
2.11	0.4826	2.12	0.4830	2.13	0.4834	2.14	0.4838	2.15	0.4842	2.16	0.4846	2.17	0.4850	2.18	0.4854	2.19	0.4857	2.20	0.4861
2.21	0.4864	2.22	0.4868	2.23	0.4871	2.24	0.4875	2.25	0.4878	2.26	0.4881	2.27	0.4884	2.28	0.4887	2.29	0.4890	2.30	0.4893
2.31	0.4896	2.32	0.4898	2.33	0.4901	2.34	0.4904	2.35	0.4906	2.36	0.4909	2.37	0.4911	2.38	0.4913	2.39	0.4916	2.40	0.4918
2.41	0.4920	2.42	0.4922	2.43	0.4925	2.44	0.4927	2.45	0.4929	2.46	0.4931	2.47	0.4932	2.48	0.4934	2.49	0.4936	2.50	0.4938
2.51	0.4940	2.52	0.4941	2.53	0.4943	2.54	0.4945	2.55	0.4946	2.56	0.4948	2.57	0.4949	2.58	0.4951	2.59	0.4952	2.60	0.4953
2.61	0.4955	2.62	0.4956	2.63	0.4957	2.64	0.4959	2.65	0.4960	2.66	0.4961	2.67	0.4962	2.68	0.4963	2.69	0.4964	2.70	0.4965
2.71	0.4966	2.72	0.4967	2.73	0.4968	2.74	0.4969	2.75	0.4970	2.76	0.4971	2.77	0.4972	2.78	0.4973	2.79	0.4974	2.80	0.4974
2.81	0.4975	2.82	0.4976	2.83	0.4977	2.84	0.4977	2.85	0.4978	2.86	0.4979	2.87	0.4979	2.88	0.4980	2.89	0.4981	2.90	0.4981
2.91	0.4982	2.92	0.4982	2.93	0.4983	2.94	0.4984	2.95	0.4984	2.96	0.4985	2.97	0.4985	2.98	0.4986	2.99	0.4986	3.00	0.4987
3.01	0.4987	3.02	0.4987	3.03	0.4988	3.04	0.4988	3.05	0.4989	3.06	0.4989	3.07	0.4989	3.08	0.4990	3.09	0.4990	3.10	0.4990
3.11	0.4991	3.12	0.4991	3.13	0.4991	3.14	0.4992	3.15	0.4992	3.16	0.4992	3.17	0.4992	3.18	0.4993	3.19	0.4993	3.20	0.4993
3.21	0.4993	3.22	0.4994	3.23	0.4994	3.24	0.4994	3.25	0.4994	3.26	0.4994	3.27	0.4995	3.28	0.4995	3.29	0.4995	3.30	0.4995
3.31	0.4995	3.32	0.4995	3.33	0.4996	3.34	0.4996	3.35	0.4996	3.36	0.4996	3.37	0.4996	3.38	0.4996	3.39	0.4997	3.40	0.4997
3.41	0.4997	3.42	0.4997	3.43	0.4997	3.44	0.4997	3.45	0.4997	3.46	0.4997	3.47	0.4997	3.48	0.4997	3.49	0.4998	3.50	0.4998
3.51	0.4998	3.52	0.4998	3.53	0.4998	3.54	0.4998	3.55	0.4998	3.56	0.4998	3.57	0.4998	3.58	0.4998	3.59	0.4998	3.60	0.4998
3.61	0.4998	3.62	0.4999	3.63	0.4999	3.64	0.4999	3.65	0.4999	3.66	0.4999	3.67	0.4999	3.68	0.4999	3.69	0.4999	3.70	0.4999
3.71	0.4999	3.72	0.4999	3.73	0.4999	3.74	0.4999	3.75	0.4999	3.76	0.4999	3.77	0.4999	3.78	0.4999	3.79	0.4999	3.80	0.4999
3.81	0.4999	3.82	0.4999	3.83	0.4999	3.84	0.4999	3.85	0.4999	3.86	0.4999	3.87	0.4999	3.88	0.4999	3.89	0.4999	3.90	0.4999
3.91	0.5000	3.92	0.5000	3.93	0.5000	3.94	0.5000	3.95	0.5000	3.96	0.5000	3.97	0.5000	3.98	0.5000	3.99	0.5000	4.00	0.5000

PROBABILITY OF A HIT ON A 50.00 FOOT SQUARE TARGET AT 1500. METERS

RADIAL STD DEV -MILS	LINEAR STD DEV -FEET	7	DIFF	INTER- POLA- TION	AREA OF NORMAL CURVE	PHX ON HALF OF TGT	PHX FULL TARGET	PM FULL TGT X AND Y	PER CENT
6.5	22.6190	1.1053	0.0022	0.0012	0.3643	0.3655	0.7309	0.5342	53.42
7.0	24.3589	1.0763	0.0024	0.0015	0.3461	0.3476	0.6952	0.4833	48.23
7.5	26.0989	0.9579	0.0026	0.0021	0.3289	0.3310	0.6619	0.4361	43.61
8.0	27.8388	0.8980	0.0026	0.0021	0.3133	0.3154	0.6308	0.3979	39.79
8.5	29.5787	0.8452	0.0028	0.0015	0.2995	0.3010	0.6019	0.3623	36.23
9.0	31.3186	0.7962	0.0029	0.0024	0.2852	0.2876	0.5752	0.3308	33.08
9.5	33.0586	0.7562	0.0030	0.0019	0.2734	0.2753	0.5505	0.3031	30.31
10.0	34.7985	0.7184	0.0031	0.0026	0.2611	0.2637	0.5274	0.2782	27.82
10.5	36.5384	0.6842	0.0032	0.0013	0.2517	0.2530	0.5061	0.2561	25.61
11.0	38.2783	0.6531	0.0032	0.0010	0.2422	0.2432	0.4864	0.2366	23.66
11.5	40.0183	0.6247	0.0033	0.0016	0.2324	0.2340	0.4670	0.2189	21.89
12.0	41.7582	0.5987	0.0033	0.0029	0.2224	0.2253	0.4505	0.2030	20.30
12.5	43.4981	0.5747	0.0033	0.0016	0.2127	0.2173	0.4345	0.1868	18.68
13.0	45.2380	0.5526	0.0035	0.0009	0.2028	0.2097	0.4194	0.1759	17.59
13.5	46.9780	0.5322	0.0035	0.0008	0.2019	0.2027	0.4053	0.1643	16.43
14.0	48.7179	0.5132	0.0035	0.0011	0.1950	0.1961	0.3922	0.1538	15.38
14.5	50.4578	0.4955	0.0036	0.0020	0.1879	0.1899	0.3797	0.1442	14.42
15.0	52.1977	0.4789	0.0036	0.0032	0.1808	0.1840	0.3680	0.1355	13.55
15.5	53.9376	0.4635	0.0036	0.0013	0.1772	0.1785	0.3569	0.1274	12.74
16.0	55.6776	0.4490	0.0036	0.0032	0.1700	0.1732	0.3465	0.1201	12.01
16.5	57.4175	0.4354	0.0036	0.0019	0.1664	0.1683	0.3367	0.1134	11.34
17.0	59.1574	0.4226	0.0035	0.0009	0.1628	0.1637	0.3275	0.1072	10.72
17.5	60.8973	0.4105	0.0037	0.0002	0.1591	0.1593	0.3164	0.1015	10.15
18.0	62.6373	0.3991	0.0037	0.0034	0.1517	0.1551	0.3102	0.0962	9.62
18.5	64.3772	0.3883	0.0037	0.0031	0.1480	0.1511	0.3022	0.0913	9.13
19.0	66.1171	0.3781	0.0037	0.0030	0.1443	0.1473	0.2946	0.0868	8.68
19.5	67.8570	0.3684	0.0037	0.0031	0.1404	0.1437	0.2874	0.0826	8.26
20.0	69.5970	0.3592	0.0038	0.0035	0.1368	0.1403	0.2806	0.0787	7.87
20.5	71.3369	0.3504	0.0038	0.0002	0.1368	0.1370	0.2739	0.0750	7.50
21.0	73.0768	0.3421	0.0037	0.0008	0.1331	0.1339	0.2678	0.0717	7.17
21.5	74.8167	0.3341	0.0038	0.0016	0.1293	0.1309	0.2618	0.0685	6.85
22.0	76.5567	0.3266	0.0038	0.0025	0.1255	0.1280	0.2560	0.0655	6.55
22.5	78.2966	0.3193	0.0038	0.0035	0.1217	0.1252	0.2505	0.0627	6.27
23.0	80.0365	0.3124	0.0038	0.0009	0.1217	0.1226	0.2452	0.0601	6.01
23.5	81.7764	0.3057	0.0038	0.0022	0.1179	0.1201	0.2401	0.0577	5.77
24.0	83.5164	0.2993	0.0038	0.0036	0.1141	0.1177	0.2353	0.0554	5.54
24.5	85.2563	0.2932	0.0038	0.0012	0.1141	0.1153	0.2307	0.0532	5.32
25.0	86.9962	0.2874	0.0038	0.0028	0.1103	0.1131	0.2262	0.0512	5.12
25.5	88.7361	0.2817	0.0038	0.0007	0.1103	0.1110	0.2219	0.0492	4.92
26.0	90.4761	0.2763	0.0039	0.0025	0.1064	0.1089	0.2177	0.0474	4.74

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4. PROGRAM R454R

a. DESCRIPTION

This program gives calculations for single-shot and ten-shot hit probabilities in a direct approach to the target. In addition, it gives single- and ten-shot hit probabilities for targets approached at two different angles from the horizontal where, for a 50-foot target at approach angle of 25 degrees,

$$x = 25$$

$$y = 25 \cos 25^\circ$$

Load limits equal 2586(DECIMAL) words.

b. OUTPUT

- (1) First page - Values of the normal curve as read in from 80-column cards.
- (2) Second and subsequent pages -

Column

1	Radial Standard Deviation - mils	
2	Range - meters	
3	Target Size - feet	
4	Hit Probability, Single Shot -	0 Degree Approach
5	Hit Probability, Single Shot -	-- Degree Approach
6	Hit Probability, Single Shot -	-- Degree Approach
7	Hit Probability, Ten Shots -	0 Degree Approach
8	Hit Probability, Ten Shots -	-- Degree Approach
9	Hit Probability, Ten Shots -	-- Degree Approach

c. INPUT

- (1) Set of 50 cards with values of the normal curve area as described under Program R453R.
- (2) Followed by Data Cards.

<u>Column</u>	<u>Variable Name</u>	<u>Description</u>
1-5	RSDIN	Initial radial standard deviation - mils
6-10	RINC	Increments of RSD
11-15	RSDFI	Final RSD
16-20	DSTIN	Initial distance from target - meters
21-25	DINC	Increments of distance

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4. PROGRAM R454R - Continued

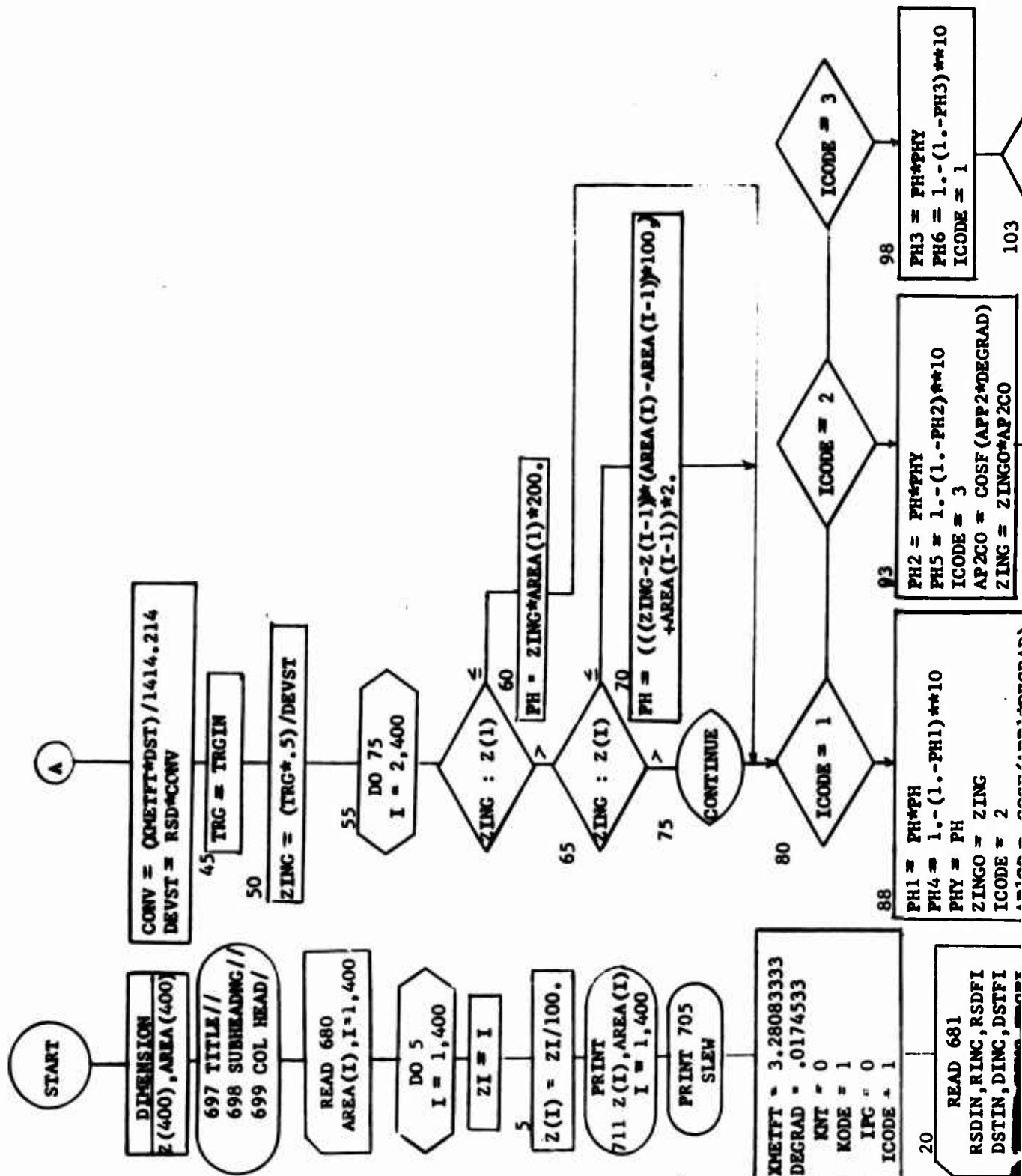
c. INPUT

<u>Column</u>	<u>Variable</u> <u>Name</u>	
26-30	DSTFI	Final distance from target
31-35	TRGIN	Initial length and width of target - feet
36-40	TINC	Increments of target edge
41-45	TRGFI	Final target edge
46-50	APP1	First approach angle
51-55	APP2	Second approach angle
56-60	COUNT	Line count per page

Line count of the sample problem was 44 lines, which includes a 4-line count for the heading and 40 printed lines of data. Title lines and page numbers are not included in the count.

PROGRAM R454R PHIT ON A SQUARE TARGET AT DIRECT AND TWO ANGULAR APPROACHES

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RSDFT = 5.28083333
 DEGRAD = .0174533
 KNT = 0
 CODE = 1
 IPC = 0
 ICODE = 1

READ 681
 RSDIN, RINC, RSDFI
 DSTIN, DINC, DSTFI
 TRGIN, TINC, TRGFI
 APP1, APP2, COUNT

RSDIN : 0
 KAPP1 = APP1
 KAPP2 = APP2
 KOUNT = COUNT

KNT : 0
 700 HEADINGS
 701
 702

KNT = KNT+4
 IPC = IPC+1

RSD = RSDIN

DST = DSTIN

IDST = DST

A

ICODE = 1
 ICODE = 2
 ICODE = 3
 PH1 = PH*PH
 PH4 = 1.-(1.-PH1)**10
 PH2 = PH*PH
 PH5 = 1.-(1.-PH2)**10
 PH3 = PH*PH
 PH6 = 1.-(1.-PH3)**10
 PHY = PH
 ZINGO = ZING
 ICODE = 2
 AP1CO = COSF (APP1*DEGRAD)
 ZING = ZING*AP1CO
 ICODE = 3
 AP2CO = COSF (APP2*DEGRAD)
 ZING = ZING*AP2CO

KNT : KOUNT
 KNT = KNT+1
 PRINT 706
 RSD, IDST, TRG
 PH1 - PH6
 PRINT 707
 IDST, TRG
 PH1 - PH6
 PRINT 708
 TRG
 PH1 - PH6

CODE = 1
 CODE = 2
 CODE = 3
 KNT = KNT+1
 KNT = 4
 IPC = IPC+1

TINC : 0
 DINC : 0
 RINC : 0
 TRG = TRG+TINC
 DST = DST+DINC
 RSD = RSD+RINC
 TRG : TRGFI
 DST : DSTFI
 RSD : RSDFI

703 //
 704 IPC
 705 SLEW
 706 COL. HEAD.
 701 "
 702 KAPP1, KAPP2
 KAPP1, KAPP2
 706 RSD, IDST, TRG
 PH1 - PH6

130

20

35

40

50

55

999

STOP

```

C      PROGRAM R454R      CHARGE TO R701R      BY H. LUNDY
C      PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES
C      INTERPOLATED FROM 400 VALUES OF THE NORMAL CURVE READ IN FROM CARDS
C      ICODE      - STORAGE CONTROL
C      IPG      - COUNT OF PAGES
C      KNT AND KOUNT      - COUNT OF PRINTED LINES
C      KODE      - FORMAT CONTROL
C      DIMENSION Z(400),AREA(400)
C      PRINT 697
C      PRINT 698
C      PRINT 699
C      READ 680,(AREA(I),I = 1,400)
C      DO 5 I = 1,400
C      ZI = I
C      5 Z(I) = ZI/100.
C      PRINT 711,(Z(I),AREA(I),I = 1,400)
C      PRINT 705
C      XMETFT = 3.28083333
C      DEGRAD = .0174533
C      KNT = 0
C      KODE = 1
C      IPG = 0
C      ICODE = 1
C      20 READ 681,RSDDIN,RINC,RSDFI,DSTIN,DINC,DSTFI, TRGIN,TINC,TRGFI, APP1
C      1,APP2,COUNT
C      IF(RSDIN) 999,999,25
C      25 KAPP1 = APP1
C      KAPP2 = APP2
C      KOUNT = COUNT
C      IF(KNT) 28,28,30
C      28 PRINT 700
C      PRINT 701
C      PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
C      KNT = KNT + 4
C      IPG = IPG + 1

```

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```

30 RSD = RSDIN
35 DST = DSTIN
40 IDST = DST
   CONV = (XMETFT * DST) / 1414.214
   DEVST = RSD * CONV
45 TRG = TRGIN
50 ZING = (TRG * .5) / DEVST
55 DO 75 I = 2,400
   IF(ZING - Z(I)) 60,60.65
60 PH = (ZING * AREA(I) * 200.)
   GO TO 80
65 IF(ZING - Z(I)) 70,70.75
70 PH = (((ZING - Z(I-1)) * (AREA(I) - AREA(I-1)) * 100.) * AREA(I-1)
   1)*2.
   GO TO 80
75 CONTINUE
80 GO TO (88,93,98), ICODE
88 PH1 = PH * PH
   PH4 = 1. - (1. - PH1)**10
   PHY = PH
   ZINGO = ZING
   ICODE = 2
   AP1CO = COSF(APP1 * DEGRAD)
   ZING = ZING * AP1CO
   GO TO 55
93 PH2 = PH * PHY
   PH5 = 1. - (1. - PH2)**10
   ICODE = 3
   AP2CO = COSF(APP2 * DEGRAD)
   ZING = ZINGO * AP2CO
   GO TO 55
98 PH3 = PH * PHY
   PH6 = 1. - (1. - PH3)**10
   ICODE = 1
103 IF(KNT = KOUNT) 110,105,105

```

```

105 PRINT 703
    PRINT 704,IPG
    PRINT 705
    PRINT 700
    PRINT 701
    PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
    PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    KNT = 4
    IPG = IPG + 1
    GO TO 130
110 GO TO 115,120,125], CODE
115 PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
120 PRINT 707,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
125 PRINT 708, TRG,PH1,PH2,PH3,PH4,PH5,PH6
130 KNT = KNT + 1
    IF(IINC) 140,140,135
135 TRG = TRG + IINC
    CODE = 3
    IF(TRG - TRGFI) > 0,50,140
140 IF(DINC) 150,150,145
145 DST = DST + DINC
    CODE = 2
    IF(IDST - DSTFI) 40,40,150
150 IF(RINC) 20,20,155
155 RSD = RSD + RINC
    CODE = 1
    IF(RSD - RSDFI) 35,35,20
999 PRINT 703
    PRINT 709
    STOP

```

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```

680 FORMAT (8(F4.4,6X))
681 FORMAT (12F5.0)
697 FORMAT(13X,93H PROGRAM NO R454R. PROBABILITY OF A HIT ON A SQUARE
      1 TARGET AT DIRECT AND 2 ANGULAR APPROACHES//)
698 FORMAT (49X,22HAREA OF A NORMAL CURVE//)
699 FORMAT (10(12H Z AREA //))
700 FORMAT (23H RADIAL
      1 TARGET,25X,15HHIT PROBABILITY)
701 FORMAT (22H STD DEV RANGE SIZE,17X,11HSINGLE SHOT,15X,9HTEN SHO
      1TS)
702 FORMAT (40H -MILS METERS FT X FT APPROACH 0 DEG,14.4H DEG,14.
      14H DEG,0H 0 DEG,14.4H DEG,14.4H DEG/)
703 FORMAT (//)
704 FORMAT (37X,4HPAGE,13)
705 FORMAT (1H1)
706 FORMAT (F6.1,18,F9.2,F17.4,5F8.4)
707 FORMAT (6X,18,F9.2,F17.4,5F8.4)
708 FORMAT (14X, F9.2,F17.4,5F8.4)
709 FORMAT (14H END OF REPORT)
711 FORMAT (10(F5.2,F7.4))
      END

```

AREA OF A NORMAL CURVE

-17-

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY					TEN SHOTS		
			APPROACH	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG	0 DEG
6.5	1000	50.00	0.8146	0.7826	0.6950	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.9980	0.9964	0.9800	1.0000	1.0000	1.0000	1.0000	1.0000
	2000	50.00	0.5342	0.4995	0.4133	0.9995	0.9995	0.9995	0.9995	0.9995
	2500	50.00	0.9464	0.9289	0.8580	1.0000	1.0000	1.0000	1.0000	1.0000
	3000	50.00	0.3514	0.3246	0.2621	0.9868	0.9868	0.9868	0.9868	0.9868
	1000	50.00	0.8146	0.7826	0.6950	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.2429	0.2228	0.1778	0.9381	0.9381	0.9381	0.9381	0.9381
	2000	50.00	0.6646	0.6282	0.5313	1.0000	1.0000	1.0000	1.0000	1.0000
	2500	50.00	0.1759	0.1609	0.1275	0.8556	0.8556	0.8556	0.8556	0.8556
	3000	50.00	0.5342	0.4995	0.4133	0.9995	0.9995	0.9995	0.9995	0.9995
7.0	1000	50.00	0.7679	0.7334	0.6340	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.9960	0.9928	0.9686	1.0000	1.0000	1.0000	1.0000	1.0000
	2000	50.00	0.4633	0.4503	0.3698	0.9966	0.9966	0.9966	0.9966	0.9966
	2500	50.00	0.9213	0.8996	0.8191	1.0000	1.0000	1.0000	1.0000	1.0000
	3000	50.00	0.3121	0.2874	0.2311	0.9763	0.9763	0.9763	0.9763	0.9763
	1000	50.00	0.7679	0.7334	0.6340	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.2135	0.1956	0.1596	0.9094	0.9094	0.9094	0.9094	0.9094
	2000	50.00	0.6115	0.5752	0.4818	0.9999	0.9999	0.9999	0.9999	0.9999
	2500	50.00	0.1538	0.1404	0.1111	0.8118	0.8118	0.8118	0.8118	0.8118
	3000	50.00	0.4833	0.4503	0.3698	0.9966	0.9966	0.9966	0.9966	0.9966
7.5	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.9918	0.9867	0.9538	1.0000	1.0000	1.0000	1.0000	1.0000
	2000	50.00	0.4381	0.4066	0.3321	0.9949	0.9949	0.9949	0.9949	0.9949
	2500	50.00	0.8923	0.8667	0.7788	1.0000	1.0000	1.0000	1.0000	1.0000
	3000	50.00	0.2782	0.2559	0.2050	0.9616	0.9616	0.9616	0.9616	0.9616
	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.1888	0.1728	0.1371	0.8766	0.8766	0.8766	0.8766	0.8766
	2000	50.00	0.5619	0.5265	0.4375	0.9997	0.9997	0.9997	0.9997	0.9997
	2500	50.00	0.1355	0.1236	0.0976	0.7667	0.7667	0.7667	0.7667	0.7667
	3000	50.00	0.4381	0.4068	0.3321	0.9969	0.9969	0.9969	0.9969	0.9969
8.0	1000	50.00	0.6758	0.6395	0.5418	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.9858	0.9785	0.9365	1.0000	1.0000	1.0000	1.0000	1.0000
	2000	50.00	0.3979	0.3685	0.2994	0.9937	0.9937	0.9937	0.9937	0.9937
	2500	50.00	0.8604	0.8314	0.7383	1.0000	1.0000	1.0000	1.0000	1.0000
	3000	50.00	0.2494	0.2290	0.1828	0.9432	0.9432	0.9432	0.9432	0.9432
	1000	50.00	0.6758	0.6395	0.5418	1.0000	1.0000	1.0000	1.0000	1.0000
	1500	50.00	0.1681	0.1536	0.1217	0.8412	0.8412	0.8412	0.8412	0.8412
	2000	50.00	0.5166	0.4825	0.3982	0.9993	0.9993	0.9993	0.9993	0.9993
	2500	50.00	0.1201	0.1095	0.0863	0.7217	0.7217	0.7217	0.7217	0.7217
	3000	50.00	0.3979	0.3685	0.2994	0.9937	0.9937	0.9937	0.9937	0.9937

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY									
			SINGLE SHOT					TEN SHOTS				
			APPROACH	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG
8.5	1000	50.00	0.6324	0.5959	0.5010	1.0000	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
		100.00	0.9778	0.9675	0.9167	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3623	0.3349	0.2708	0.9889	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831
		100.00	0.8264	0.7950	0.6982	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2246	0.2058	0.1639	0.9214	0.9002	0.9002	0.9002	0.9002	0.9002	0.9002
		100.00	0.6324	0.5959	0.5010	1.0000	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
		50.00	0.1505	0.1374	0.1087	0.8044	0.7719	0.7719	0.7719	0.7719	0.7719	0.7719
		100.00	0.4755	0.4427	0.3632	0.9984	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971
		50.00	0.1072	0.0977	0.0769	0.6784	0.6422	0.6422	0.6422	0.6422	0.6422	0.6422
		100.00	0.3623	0.3349	0.2708	0.9889	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831
9.0	1000	50.00	0.5911	0.5551	0.4634	0.9999	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
		100.00	0.9671	0.9539	0.8945	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3308	0.3052	0.2460	0.9820	0.9738	0.9738	0.9738	0.9738	0.9738	0.9738
		100.00	0.7914	0.7581	0.6593	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2030	0.1859	0.1478	0.8966	0.8721	0.8721	0.8721	0.8721	0.8721	0.8721
		100.00	0.5911	0.5551	0.4634	0.9999	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
		50.00	0.1355	0.1236	0.0976	0.7667	0.7326	0.7326	0.7326	0.7326	0.7326	0.7326
		100.00	0.4381	0.4068	0.3321	0.9969	0.9946	0.9946	0.9946	0.9946	0.9946	0.9946
		50.00	0.0962	0.0876	0.0689	0.6363	0.6002	0.6002	0.6002	0.6002	0.6002	0.6002
		100.00	0.3308	0.3052	0.2460	0.9820	0.9738	0.9738	0.9738	0.9738	0.9738	0.9738
9.5	1000	50.00	0.5527	0.5175	0.4293	0.9997	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993
		100.00	0.9540	0.9379	0.8706	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3031	0.2790	0.2241	0.9730	0.9621	0.9621	0.9621	0.9621	0.9621	0.9621
		100.00	0.7562	0.7214	0.6219	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.1845	0.1687	0.1338	0.8698	0.8424	0.8424	0.8424	0.8424	0.8424	0.8424
		100.00	0.5527	0.5175	0.4293	0.9997	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993
		50.00	0.1224	0.1117	0.0880	0.7291	0.6939	0.6939	0.6939	0.6939	0.6939	0.6939
		100.00	0.4043	0.3746	0.3045	0.9944	0.9908	0.9908	0.9908	0.9908	0.9908	0.9908
		50.00	0.0868	0.0790	0.0621	0.5966	0.5609	0.5609	0.5609	0.5609	0.5609	0.5609
		100.00	0.3031	0.2790	0.2241	0.9730	0.9621	0.9621	0.9621	0.9621	0.9621	0.9621
10.0	1000	50.00	0.5166	0.4825	0.3982	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993
		100.00	0.9386	0.9196	0.8452	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2782	0.2559	0.2050	0.9616	0.9479	0.9479	0.9479	0.9479	0.9479	0.9479
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.8113	0.8113	0.8113	0.8113	0.8113
		100.00	0.5166	0.4825	0.3982	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993
		50.00	0.1113	0.1014	0.0799	0.6926	0.6566	0.6566	0.6566	0.6566	0.6566	0.6566
		100.00	0.3737	0.3456	0.2799	0.9907	0.9856	0.9856	0.9856	0.9856	0.9856	0.9856
		50.00	0.0787	0.0716	0.0563	0.5596	0.5244	0.5244	0.5244	0.5244	0.5244	0.5244
		100.00	0.2782	0.2559	0.2050	0.9616	0.9479	0.9479	0.9479	0.9479	0.9479	0.9479

END OF REPORT

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5. PROGRAM R455R

a. DESCRIPTION

This program gives the same 9-column output as Program R454R, but the calculations are based on integration of the normal curve by Simpson's 1/3 Rule. The actual integration is carried out by use of the equation

$$Y(I) = \frac{1}{\sqrt{2\pi}} e^{-(t^2/2)}$$

or

$$Y(I) = .392944 \times \text{EXPF}(-X \times X \times .5)$$

in the SUBROUTINE CVNORM. Load limits equal 2151(DECIMAL) words, including the SUBROUTINE.

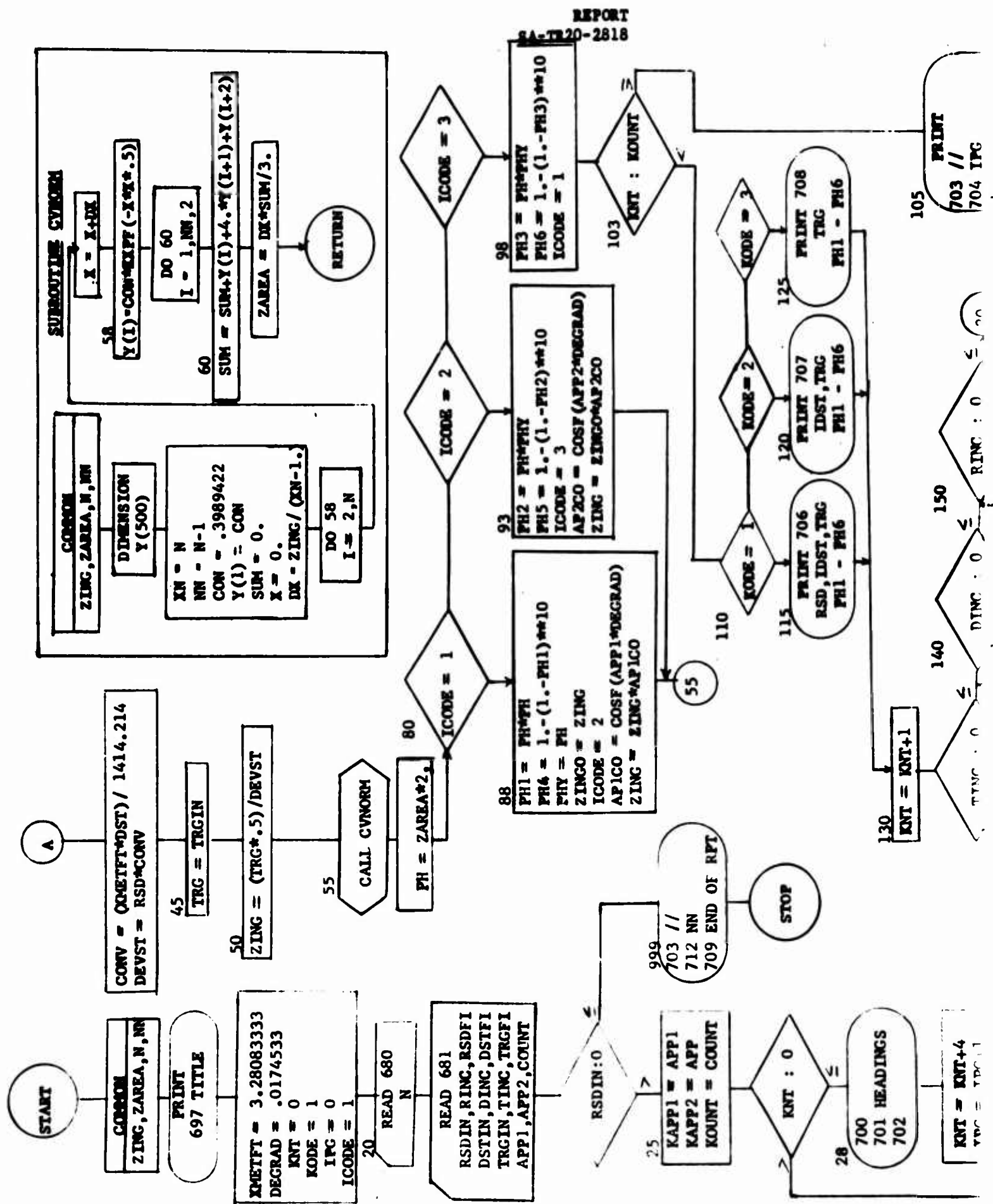
b. OUTPUT

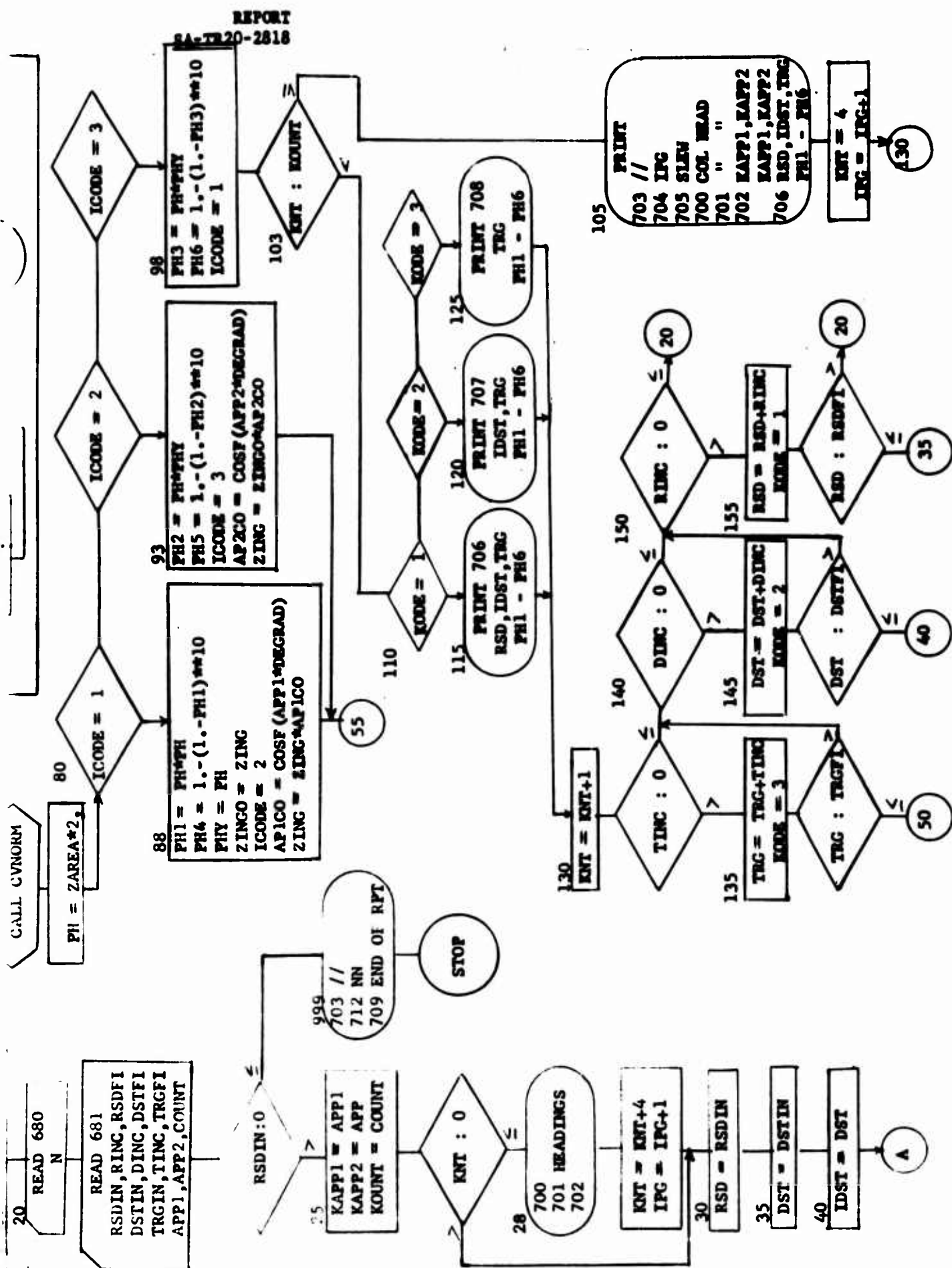
Same as second and subsequent pages of Program R454R except that the final page also gives the number of incremental areas considered in the calculations.

c. INPUT

- (1) First Card, Columns 1-5, number of increments of area to be calculated, I format.
- (2) Second Card, Data Card fully described under Program R454R.

INTEGRATION OF THE NORMAL CURVE BY SIMPSON'S 1/3 RULE





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C      PROGRAM R455K  CHARGE TO R701R  BY H. LUNNY
C      PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES
C      INTEGRATION OF THE NORMAL CURVE BY SIMPSON'S 1/3 RULE
C      SUBROUTINE CVMORM IS CALLED
C      N MUST BE ODD
C      ICODE      - STORAGE CONTROL
C      IPG        - COUNT OF PAGES
C      KNT AND KOUNT  - COUNT OF PRINTED LINES
C      KODE       - FORMAT CONTROL
C      COMMON ZING, ZAREA, N, NN
C      PRINT 697
C      XMETFT = 3.28083333
C      DEGRAD = .0174533
C      KNT = 0
C      KODE = 1
C      IPG = 0
C      ICODE = 1
20  READ 680, N
    READ 681, RSDIN, RINC, RSDFI, DSTIN, DINC, DSTFI, TRGIN, TINC, TRGFI, APP1
    1, APP2, COUNT
    IF (RSDIN) 999, 999, 25
25  KAPP1 = APP1
    KAPP2 = APP2
    KOUNT = COUNT
    IF (KNT) 28, 28, 30
28  PRINT 700
    PRINT 701
    PRINT 702, KAPP1, KAPP2, KAPP1, KAPP2
    KNT = KNT + 4
    IPG = IPG + 1
30  RSD = RSDIN
35  DST = DSTIN
40  IDST = DST
    CONV = (XMETFT * DST) / 1414.214
    DEVST = RSD * CONV
45  TRG = TRGIN
50  ZING = (TRG * .5) / DEVST

```

```

55 CALL CVNORM
   PH = ZAREA * 2.
80 GO TO (68,93,98), ICODE
88 PH1 = PH * PH
   PH4 = 1. - (1. - PH1)**10
   PH5 = PH
   ZINGO = ZING
   ICODE = 2
   AP1CO = CUSF(APP1 * DEGRAD)
   ZING = ZING * AP1CO
   GO TO 55
93 PH2 = PH * PH
   PH5 = 1. - (1. - PH2)**10
   ICODE = 3
   AP2CO = CUSF(APP2 * DEGRAD)
   ZING = ZINGO * AP2CO
   GO TO 55
98 PH3 = PH * PH
   PH6 = 1. - (1. - PH3)**10
   ICODE = 1
103 IF(KNT = KOUNT) 110,105,105
105 PRINT 703
   PRINT 704,IPG
   PRINT 705
   PRINT 700
   PRINT 701
   PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
   PRINT 706,RSO,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
   KNT = 4
   IPG = IPG + 1
   GO TO 130
110 GO TO (115,120,125), KODE
115 PRINT 706,RSO,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
   GO TO 130
120 PRINT 707,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
   GO TO 130
125 PRINT 708, TRG,PH1,PH2,PH3,PH4,PH5,PH6
130 KNT = KNT + 1

```

```

135 IF(IINC) 140,140,135
    TRG = TRG + IINC
    KODE = 3
    IF(TRG - TRGT) 50,50,140
140 IF(IINC) 150,150,145
145 DST = DST + IINC
    KODE = 2
    IF(DST - DSTF) 40,40,150
150 IF(IINC) 20,20,155
155 RSD = RSD + IINC
    KODE = 1
    IF(RSD - RSDF) 35,35,20
999 PRINT 703
    PRINT 712, NN
    PRINT 709
    STOP
680 FORMAT (I5)
681 FORMAT (I2F5.0)
697 FORMAT (30H PROGRAM R455R BY M. LUNDY/ 77H PROBABILITY OF A
    HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES//)
700 FORMAT (23H RADIAL TARGET,25X,15H HIT PROBABILITY)
701 FORMAT (22H STD DEV RANGE SIZE,17X,11HSINGLE SHOT,15X,9HTEN SHO
    ITS)
702 FORMAT (40H -MILS METERS FT X FT APPROACH 0 DEG,14,4H DEG,14,
    14H DEG,0H 0 DEG,14,4H DEG,14,4H DEG//)
703 FORMAT (//)
704 FORMAT (37X,4HPAGE,I3)
705 FORMAT (1H1)
706 FORMAT (F6.1,I8,F9.2,F17.4,5F8.4)
707 FORMAT (6X,I8,F9.2,F17.4,5F8.4)
708 FORMAT (14X,F9.2,F17.4,5F8.4)
709 FORMAT (14H END OF REPORT)
712 FORMAT (38H HIT PROBABILITY CALCULATIONS BASED ON, 14, 39H INCKEN
    TIAL AREAS OF THE NORMAL CURVE//)
    END

```

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```
SUBROUTINE CVNORM
COMMON ZING, ZAREA, N, NN
DIMENSION Y(500)
XN = N
NN = N - 1
CON = .3989422
Y(1) = CON
SUM = 0.
X = 0.
DX = ZING / (XN - 1.)
DO 58 I = 2, N
  X = X + DX
  58 Y(I) = CON * EXPF[-X * X * .5]
  DO 60 J = 1, NN, 2
    60 SUM = SUM + Y(I) + 4.*Y(I+1) + Y(I+2)
  ZAREA = DX * SUM / 3.
RETURN
END
```


PROGRAM R455M BY M. LUNDY
PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY					TEN SHOTS				
			APPROACH	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG
6.5	1000	50.00	0.8148	0.7827	0.6851	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		100.00	0.9982	0.9964	0.9801	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		1500	0.5343	0.4996	0.4134	0.9995	0.9995	0.9990	0.9990	0.9990	0.9990	0.9992
		2000	0.9466	0.9290	0.8581	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	2500	50.00	0.3515	0.3246	0.2622	0.9868	0.9868	0.9802	0.9802	0.9522	0.9522	0.9522
		100.00	0.8148	0.7827	0.6851	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		1500	0.2428	0.2228	0.1778	0.9381	0.9381	0.9196	0.9196	0.8589	0.8589	0.8589
		2000	0.6647	0.6283	0.5313	1.0000	1.0000	0.9999	0.9999	0.9595	0.9595	0.9595
	3000	50.00	0.1760	0.1609	0.1275	0.8556	0.8556	0.8269	0.8269	0.7445	0.7445	0.7445
		100.00	0.5343	0.4996	0.4134	0.9995	0.9995	0.9990	0.9990	0.9952	0.9952	0.9952
		1500	0.7679	0.7335	0.6341	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		2000	0.9958	0.9927	0.9685	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.0	1500	50.00	0.4834	0.4503	0.3699	0.9986	0.9986	0.9975	0.9975	0.9901	0.9901	0.9901
		100.00	0.9214	0.8996	0.8191	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		2000	0.3120	0.2874	0.2311	0.9762	0.9762	0.9662	0.9662	0.9278	0.9278	0.9278
		2500	0.7679	0.7335	0.6341	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	3000	50.00	0.2134	0.1955	0.1556	0.9093	0.9093	0.8865	0.8865	0.8156	0.8156	0.8156
		100.00	0.6114	0.5752	0.4818	0.9999	0.9999	0.9998	0.9998	0.9986	0.9986	0.9986
		1500	0.1538	0.1404	0.1111	0.8117	0.8117	0.7798	0.7798	0.6920	0.6920	0.6920
		2000	0.4834	0.4503	0.3699	0.9986	0.9986	0.9975	0.9975	0.9901	0.9901	0.9901
	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	0.9999	0.9999	0.9999
		100.00	0.9919	0.9868	0.9540	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		1500	0.4381	0.4069	0.3321	0.9969	0.9969	0.9946	0.9946	0.9823	0.9823	0.9823
		2000	0.8923	0.8667	0.7788	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8.0	2500	50.00	0.2783	0.2559	0.2050	0.9616	0.9616	0.9479	0.9479	0.8991	0.8991	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	0.9999	0.9999	0.9999
		1500	0.1688	0.1728	0.1371	0.8766	0.8766	0.8499	0.8499	0.7712	0.7712	0.7712
		2000	0.5620	0.5266	0.4375	0.9997	0.9997	0.9994	0.9994	0.9968	0.9968	0.9968
	3000	50.00	0.1354	0.1236	0.0976	0.7667	0.7667	0.7326	0.7326	0.6418	0.6418	0.6418
		100.00	0.4381	0.4069	0.3321	0.9969	0.9969	0.9946	0.9946	0.9823	0.9823	0.9823
		1500	0.6757	0.6394	0.5418	1.0000	1.0000	1.0000	1.0000	0.9996	0.9996	0.9996
		2000	0.9659	0.9784	0.9366	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	1000	50.00	0.3979	0.3686	0.2994	0.9937	0.9937	0.9899	0.9899	0.9715	0.9715	0.9715
		100.00	0.8603	0.8314	0.7382	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		1500	0.2494	0.2289	0.1828	0.9432	0.9432	0.9257	0.9257	0.8672	0.8672	0.8672
		2000	0.6757	0.6394	0.5418	1.0000	1.0000	1.0000	1.0000	0.9996	0.9996	0.9996
8.0	2500	50.00	0.1681	0.1536	0.1217	0.8412	0.8412	0.8113	0.8113	0.7268	0.7268	0.7268
		100.00	0.5167	0.4825	0.3982	0.9993	0.9993	0.9986	0.9986	0.9938	0.9938	0.9938
		1500	0.1201	0.1095	0.0863	0.7219	0.7219	0.6864	0.6864	0.5947	0.5947	0.5947
		2000	0.3979	0.3686	0.2994	0.9937	0.9937	0.9899	0.9899	0.9715	0.9715	0.9715

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RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY					TEN SHOTS	
			APPROACH	0 DEG	25 DEG	45 DEG	0 DEG	25 DEG	45 DEG
8.5	1000	50.00	0.6322	0.5959	0.5099	1.0000	0.9999	0.9999	0.9999
		100.00	0.9777	0.9675	0.9166	1.0000	1.0000	1.0000	1.0000
		50.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9831	0.9575
		100.00	0.8264	0.7949	0.6982	1.0000	1.0000	1.0000	1.0000
		50.00	0.2245	0.2050	0.1640	0.9214	0.9082	0.9082	0.8332
	2500	100.00	0.6322	0.5959	0.5099	1.0000	0.9999	0.9999	0.9999
		50.00	0.1505	0.1374	0.1087	0.8043	0.7719	0.7719	0.6834
		100.00	0.4755	0.4427	0.3632	0.9984	0.9971	0.9971	0.9898
		50.00	0.1072	0.0977	0.0769	0.6782	0.6422	0.6422	0.5508
		100.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9831	0.9575
9.0	1000	50.00	0.5911	0.5552	0.4635	0.9999	0.9999	0.9997	0.9988
		100.00	0.9670	0.9539	0.8945	1.0000	1.0000	1.0000	1.0000
		50.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9738	0.9486
		100.00	0.7914	0.7580	0.6593	1.0000	1.0000	1.0000	1.0000
		50.00	0.2031	0.1859	0.1478	0.8967	0.8722	0.8722	0.7979
	2500	100.00	0.5911	0.5552	0.4635	0.9999	0.9997	0.9997	0.9988
		50.00	0.1354	0.1236	0.0976	0.7667	0.7326	0.7326	0.6418
		100.00	0.4381	0.4069	0.3321	0.9969	0.9946	0.9946	0.9823
		50.00	0.0962	0.0876	0.0689	0.6364	0.6003	0.6003	0.5104
		100.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9738	0.9486
9.5	1000	50.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9993	0.9963
		100.00	0.9540	0.9379	0.8706	1.0000	1.0000	1.0000	1.0000
		50.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9621	0.9210
		100.00	0.7562	0.7214	0.6219	1.0000	1.0000	1.0000	0.9999
		50.00	0.1844	0.1687	0.1338	0.8697	0.8423	0.8423	0.7622
	2500	100.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9993	0.9963
		50.00	0.1225	0.1117	0.0881	0.7293	0.6940	0.6940	0.6023
		100.00	0.4043	0.3746	0.3045	0.9944	0.9909	0.9909	0.9735
		50.00	0.0868	0.0790	0.0621	0.5968	0.5610	0.5610	0.4734
		100.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9621	0.9210
10.0	1000	50.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9986	0.9938
		100.00	0.9387	0.9197	0.8453	1.0000	1.0000	1.0000	1.0000
		50.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	0.9999
		50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.8113	0.7268
	2500	100.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9986	0.9938
		50.00	0.1113	0.1014	0.0799	0.6926	0.6567	0.6567	0.5651
		100.00	0.3738	0.3457	0.2799	0.9907	0.9856	0.9856	0.9625
		50.00	0.0787	0.0716	0.0563	0.5595	0.5243	0.5243	0.4395
		100.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.9479	0.8991

HIT PROBABILITY CALCULATIONS BASED ON 100 INCREMENTAL AREAS OF THE NORMAL CURVE

END OF REPORT

PROGRAM R455K BY M. LUNDY
PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY									
			SINGLE SHOT					TEN SHOTS				
			0 DEG	25 DEG	45 DEG	0 DEG	45 DEG	0 DEG	25 DEG	45 DEG	0 DEG	45 DEG
6.5	1000	50.00	0.8148	0.7827	0.6851	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		100.00	0.9982	0.9964	0.9800	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.5343	0.4996	0.4134	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
		100.00	0.9466	0.9290	0.8581	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3515	0.3246	0.2622	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868
	2500	100.00	0.8146	0.7827	0.6851	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2428	0.2228	0.1778	0.9381	0.9381	0.9381	0.9381	0.9381	0.9381	0.9381
		100.00	0.6647	0.6283	0.5313	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.1760	0.1609	0.1275	0.8556	0.8556	0.8556	0.8556	0.8556	0.8556	0.8556
		100.00	0.5343	0.4996	0.4134	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
7.0	1000	50.00	0.7679	0.7335	0.6342	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		100.00	0.9958	0.9927	0.9685	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.4834	0.4503	0.3699	0.9986	0.9986	0.9986	0.9986	0.9986	0.9986	0.9986
		100.00	0.9214	0.8996	0.8191	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3120	0.2874	0.2311	0.9762	0.9762	0.9762	0.9762	0.9762	0.9762	0.9762
	2500	100.00	0.7679	0.7335	0.6342	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2134	0.1955	0.1556	0.9093	0.9093	0.9093	0.9093	0.9093	0.9093	0.9093
		100.00	0.6114	0.5752	0.4818	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
		50.00	0.1538	0.1404	0.1111	0.8117	0.8117	0.8117	0.8117	0.8117	0.8117	0.8117
		100.00	0.4834	0.4503	0.3699	0.9986	0.9986	0.9986	0.9986	0.9986	0.9986	0.9986
7.5	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		100.00	0.9919	0.9868	0.9540	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.4381	0.4069	0.3321	0.9969	0.9969	0.9969	0.9969	0.9969	0.9969	0.9969
		100.00	0.8923	0.8667	0.7788	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2783	0.2559	0.2050	0.9616	0.9616	0.9616	0.9616	0.9616	0.9616	0.9616
	2500	100.00	0.7212	0.6855	0.5863	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.1888	0.1728	0.1371	0.8766	0.8766	0.8766	0.8766	0.8766	0.8766	0.8766
		100.00	0.5620	0.5266	0.4375	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
		50.00	0.1354	0.1236	0.0976	0.7667	0.7667	0.7667	0.7667	0.7667	0.7667	0.7667
		100.00	0.4381	0.4069	0.3321	0.9969	0.9969	0.9969	0.9969	0.9969	0.9969	0.9969
8.0	1000	50.00	0.6757	0.6394	0.5419	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		100.00	0.9859	0.9784	0.9366	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.3979	0.3686	0.2994	0.9937	0.9937	0.9937	0.9937	0.9937	0.9937	0.9937
		100.00	0.8603	0.8314	0.7382	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.2494	0.2289	0.1828	0.9432	0.9432	0.9432	0.9432	0.9432	0.9432	0.9432
	2500	100.00	0.6757	0.6394	0.5419	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		50.00	0.1681	0.1536	0.1217	0.8412	0.8412	0.8412	0.8412	0.8412	0.8412	0.8412
		100.00	0.5167	0.4825	0.3982	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993
		50.00	0.1201	0.1095	0.0863	0.7219	0.7219	0.7219	0.7219	0.7219	0.7219	0.7219
		100.00	0.3979	0.3686	0.2994	0.9937	0.9937	0.9937	0.9937	0.9937	0.9937	0.9937

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RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY									
			APPROACH		SINGLE SHOT		0 DEG		45 DEG		0 DEG	
			0	DEG	25	DEG	45	DEG	0	DEG	25	DEG
8.5	1000	50.00	0.6322		0.5959		0.5009		1.0000		0.9999	
		100.00	0.9777		0.9674		0.9166		1.0000		1.0000	
		50.00	0.3624		0.3349		0.2709		0.9889		0.9831	
		100.00	0.8264		0.7949		0.6982		1.0000		1.0000	
		50.00	0.2245		0.2058		0.1640		0.9214		0.9002	
	2500	50.00	0.6322		0.5959		0.5009		1.0000		0.9999	
		100.00	0.1505		0.1374		0.1087		0.8043		0.7719	
		50.00	0.4755		0.4427		0.3632		0.9984		0.9971	
		100.00	0.1072		0.0977		0.0769		0.6782		0.6422	
		50.00	0.3624		0.3349		0.2709		0.9889		0.9831	
9.0	1000	50.00	0.5911		0.5552		0.4635		0.9999		0.9997	
		100.00	0.9670		0.9539		0.8945		1.0000		1.0000	
		50.00	0.3309		0.3052		0.2460		0.9820		0.9738	
		100.00	0.7914		0.7580		0.6593		1.0000		1.0000	
		50.00	0.2031		0.1859		0.1478		0.8967		0.8722	
	2500	50.00	0.5911		0.5552		0.4635		0.9999		0.9997	
		100.00	0.1354		0.1236		0.0976		0.7667		0.7326	
		50.00	0.4381		0.4069		0.3321		0.9969		0.9946	
		100.00	0.0962		0.0876		0.0689		0.6364		0.6003	
		50.00	0.3309		0.3052		0.2460		0.9820		0.9738	
9.5	1000	50.00	0.5526		0.5174		0.4293		0.9997		0.9993	
		100.00	0.9540		0.9379		0.8706		1.0000		1.0000	
		50.00	0.3030		0.2790		0.2241		0.9730		0.9621	
		100.00	0.7562		0.7214		0.6219		1.0000		1.0000	
		50.00	0.1844		0.1687		0.1338		0.8697		0.8423	
	2500	50.00	0.5526		0.5174		0.4293		0.9997		0.9993	
		100.00	0.1225		0.1117		0.0891		0.7293		0.6940	
		50.00	0.4043		0.3746		0.3045		0.9944		0.9909	
		100.00	0.0868		0.0790		0.0621		0.5968		0.5610	
		50.00	0.3030		0.2790		0.2241		0.9730		0.9621	
10.0	1000	50.00	0.5167		0.4825		0.3982		0.9993		0.9986	
		100.00	0.9387		0.9197		0.8453		1.0000		1.0000	
		50.00	0.2783		0.2559		0.2050		0.9616		0.9479	
		100.00	0.7212		0.6855		0.5863		1.0000		1.0000	
		50.00	0.1681		0.1536		0.1217		0.8412		0.8113	
	2500	50.00	0.5167		0.4825		0.3982		0.9993		0.9986	
		100.00	0.1113		0.1014		0.0799		0.6926		0.6567	
		50.00	0.3738		0.3457		0.2799		0.9907		0.9856	
		100.00	0.0787		0.0716		0.0563		0.5595		0.5243	
		50.00	0.2783		0.2559		0.2050		0.9616		0.9479	

HIT PROBABILITY CALCULATIONS BASED ON 10 INCREMENTAL AREAS OF THE NORMAL CURVE

END OF REPORT

APPENDIX

**REPORT
SA-TR20-2818**

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13. ABSTRACT Probability of a hit by a single shot or by a ten-shot burst at direct or angular approach to a square target is calculated. Parameters include dispersion in mils, distance from the target in meters, and size of the target in feet. A normal distribution is assumed. Solution by linear interpolation of normal curve areas from standard tables was accurate to 0.0002 when contrasted with integration of the normal curve by Simpson's 1/3 Rule in sample problems.			

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Hit probability						
2. Target						
3. Digital computer						
4. FORTRAN						

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